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DEAN UICHANCO RETIRES [1]

J. R. VELASCO

Dean Leopoldo B. Uichanco of the College of Agriculture, University of the Philippines, retires on October 31, 1959. He celebrated his sixty-fifth birthday on April 23, and applied for retirement according to law, but in appreciation for his more than forty-four years of faithful and devoted service, the Board of Regents recommended an extension of his services for six months.

The College will miss the familiar slight figure who long after five o'clock in the afternoon, comes down from the Administration Building at the wheel of an unpretentious black car—his head slightly tilted to the left; his gaze, absorbedly penetrating and seemingly divining the future. His slight build is not to be mistaken for frailness because it is capable of long and sustained hard work and it proved enduring of the worst that the Japanese Kempetai dished out.

Dean Uichanco is a scholar with a poetic turn of mind. In his earlier days he wrote of "Mount Makiling standing guard in its majestic hue and Laguna's placid waters" [2] and of the rice farmer "sowing faith across the ages in deposed, forgotten gods." Probably, this well-earned vacation will afford him some time to retrieve from "cruel oblivion all his bonds with older days." [3]

The exhaustive review of historical development in the subject he chooses to discuss (oftentimes drawing upon little known sources of information in a foreign language) and his frequent recourse to the classics are marks of his scholarly treatmennt.

POPULAR WRITING

His popular writings are characterized by their meticulous choice of words and the vivid description, on a background of cutting humor. For example, of his visit to Dansalan, he wrote, "Early in the morning, the entire Moro population is wont to pass in review

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[1] General Contribution No. 910.
[2] College of Agriculture Song (1933).
[3] *Philippine Magazine*, 27, 711 (1931).

along the banks of the Agus River in order to perform their sanitary duties. The morning view from my hotel window at Dansalan was enlivened by rows of squatting figures, with the nether ends of their trunks carelessly bared to the playful strokes of the water current." He went on, "The Maranaos impressed me as a happy, carefree people, individuals of both sexes loving to dress gaudily: and in their talk, as loud as in their clothing. Even the gumamela (*Hibiscus rosa-sinensis Linn.*) and the macopa (*Eugenia malaccensis* Linn.) bear characteristic brilliant red flowers, as if to harmonize with Moro taste. The more opulent datus embellish their houses with intricate carvings on the woodwork." [4]

Aesop-like, he made his animal stories didactic by drawing into them some of the human frailties. Thus, he exclaimed, "And imagine if we were aphids (who procreate without the aid of male aphids), what the termagant would miss without a long-suffering husband on whom to vent her wrath!" Again, "the female (aphid) in autumn in temperate regions is of a different kind from those of the spring and summer generations; the former is of the tenderly feminine, old-fashioned type that still preserves most of the traditional attributes of her sex, including dependence on the male. The spring and summer females on the other hand, are of a more modern complex, independent and self-sufficient; but, unlike their counterparts in the human species, they are not merely affecting a pose in order perhaps to attract attention or to enhance their sex-appeal for them not a male aphid exists to fall captive to their wiles." [5] He elaborated further on the eternal rivalry between the sexes, when he reported that ". . . the female mantid is more severe on her male. As the first ecstacy of mating wanes, and sometimes even while still locked in blissful embrace, she attacks the male and eats him up. By this time, the male had become useless to her, and it would be a pity to waste such good food!" [6] This acquiescent recognition of the precarious position of the male among the lower forms is probably the reason for the grapevine intelligence current for some time that entomologists trained by Dean Uichanco can not help but become very loving husbands.

Dean Uichanco's conveyance of his poignant feeling is characteristic in its matter-of-factness. Of Miss Yules' retirement as professor emerita of English, he wrote, "Thus would the last entry in

[4] *Philippine Agriculturist*, **25**, 589 (1936).
[5] *Philippine Magazine*, **26**, 419 (1929).
[6] *Philippine Magazine*, **34**, 493 (1937).

the cold, unfeeling official files record the close of nearly a quarter of a century of distinguished public service of an American teacher in the Philippines." [7] He chronicled the typhoon which hit the College on September 29 and 30, 1942, thus: "Large trees were uprooted, overland telephone, telegraph, and electric lines severed, their posts blown down, some of the buildings unroofed, and sharp pieces of iron roofing and jagged portions of tree limbs shot wildly in the air in a mad impulse to find their victims. The campus was soon thick-strewn with debris." [8]

In his playful mood, he concocted a charm over wasps and persons with ring worm:

"Hom-hom, illo hukom
ego sum empactum
Oracion sa putakte
at sa taong may bune"[9]

He reported that this polyglot doggerel in African Latin and Tagalog did not protect him from the former; he kept silent about his non-deliverance from the latter.

Apparently he anticipated the nationalists of the Nacionalista Party, but he expressed his sentiment with a pungent humor, quite strange to the straight-talking, saber-rattling brand of latter day patriots. The O. Henry-twist in this passage excites a chuckle in some readers: "Nature had not originally intended the coconut-leaf miner for the coconuts. This insect is an Oriental, . . . while the coconut is an Occidental... The earlier food of that pest must have consisted of the widely scattered wild forest palms, such as anahaw, buri, pugahan, nipa, and possibly uay. Wherever coconuts are now grown, however, the leaf miner pays but little attention to the native palms. Evidently our insects too have developed an expensive taste for imported things." [10] His pen spared nobody and humorously pricked even the munificence of America, when he said, "From being ushered into the world amidst the reassuring odor of antiseptics, little Juan de la Cruz gets drawn as a matter of course

[7] *Philippine Agriculturist*, **25**, 5 (1936).
[8] Annual Report, 1946.
[9] *Philippine Agriculturist*, **26**, 490 (1937).
[10] *Philippine Magazine*, **26**, 631 (1930).

into a vast public school system that bears the unmistakable stamp of Uncle Sam's inspiration." [11]

SCIENTIFIC DESCRIPTION

Even in the more serious scientific reports, the excellence of his word power, every once in a while come to the fore. To convey the hopelessness of locusts reared in cages, he wrote: "In February, 1937, the cage contained but a few languid adults, whose dejected forms cast the gloomy shadow of a decadent family line." [12]

His description may at times be long, but still absorbing: "Beneath the thick outer crust of clay (of the termite mound) are the 'fungus gardens' composed entirely of a mixture of fine pellets of woody excreta and plasterlike material, which have passed out of the alimentary canals of the workers. In a typical anay mound these gardens occupy the greater part of the inner cavity: compact slabs of moist clay, with numerous irregular passage ways running through them, from the partitions and, at the same time, the support of the gardens. Each garden is composed of numerous vertical galleries formed by the intersection of the walls; the general appearance is that of a sea coral, with the upper convex margin of each partition neatly finished and the lower part either unfinished or made rugged by being bitten off." [13]

He can be very technical, as entomologists go, but laymen can dodge the Latinized jargon and still make something of what he is saying. For example, "The position of the (aphid, *Macrosiphum tanaceti* L.) during molting (ecdysis) has always been found to be such that the head points toward the ground. The legs are spread far apart, so that the prothoracic pair is directed antero-laterally; the metal-thoracic, postero-laterally. The haustellum is held close to the sternum. The subcanal portion of the abdomen almost touches the surface of the plant. The antennae are directed posteriorly, and are subparallel to the lateral margin, but diverge at an angle of about thirty degrees above the dorsal surface of the body. A longitudinal mesal rupture then appears at the head, adjoining the base of the clypeus. The insect slowly forces its way through the opening thus made, in the meantime increasing the length of the rent posteriorly along the dorsomedian line of the body until the caudal margin of the metánotum is reached . . . In all probability the force

[11] *Philippine Agriculturist*, **26**, 485 (1937).
[12] *Philippine Agriculturist*, **26**, 246 (1937).
[13] *Philippine Journal of Science*, **15**, 59 (1919).

of expansion of the insect's body itself directs the course of the movement through the slit, this opening furnishing the point of least resistance in the tightly fitting exuviae. The head naturally goes out first, being nearest the rupture; and the opening enlarges as the more bulky thorax and abdomen pass out. The pro- and mesothoracic legs soon become disentangled, and it is remarkable how quickly the insect is able to spread them apart and use them to help force the rest of the body out." [14]

INDEPENDENT JUDGMENT

Dean Uichanco has maintained a healthy skepticism about theories and postulates and, whenever the facts demand, does not hesitate to challenge a pronouncement regardless of the standing of its author.

Thus on the cycle of locust outbreaks, he wrote "Uvarov's theory impliedly regards the gregarious, the solitary, and their two intermediate phases as genetically connected steps in a complete cycle that proceeds in a single direction...

"For a more adequate explanation of the trend of locust outbreak in the Philippines, ... a restatement of Uvarov's theory in a somewhat modified form is suggested. In the proposed modification, the phases are not to be considered as continuous steps in a complete unidirectional cycle; but the female gonad of the locust in any phase contains more than one type of eggs, the survival of one or the other of which is determined by a selective effect of periodically recurring factors of the environment acting upon the body of the mother. The intermediate forms vary in their affinity as regards biological and morphological potentialities toward either the solitary or the gregarious extreme. The height or subsidence of outbreaks is the end-product of these variations. Hence, it would be unnecessary to invoke constantly the existence of a solitary phase in *Locusta migatoria manilensis,* which, under the almost perennial swarm conditions obtaining in certain parts of Mindanao, is rather difficult to visualize." [15]

THOUGHTS ON SCIENCE AND SCIENCE TEACHING

Quite steeped in the arts, he opined that, "Cultural background for a scientific career is more important than is generally realized;

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[14] *Psyche, A Journal of Entomology,* **29,** 66 (1922).
[15] *Philippine Agriculturist,* **26,** 237 (1937).

it not only gives one a broader perspective but also helps sharpen his discernment—to tell which is fact and which is not fact." [16]

He challenged professional teachers when he said, "Modernized versions of educational theories notwithstanding, in the natural sciences at least, there can conceivably be no college teacher that is not also a researcher. No teaching can inspire that consists mainly of warmed-over mental food." [17] And he argued that it is never too early for us to start raising our crop of scientists in this country, for ". . . it takes the background of more than one single generation of scientists to breed a Mme. Curie, a Michelson, an Einstein or a Kitasato, and that really great scientific discoveries usually do not merely happen to fall in the way from his work by the bugaboo of finding himself thrown into the street some day as a result of 'reorganization.' " [18]

As an administrator, he adheres to a code of freedom for his researchers. He is of the opinion that "the principle of academic freedom inhibits an administrator from imposing his opinion on his colleagues, although no rule prevents him from taking part in the give-and-take of scientific discussion." [19] But freedom is not enough. The atmosphere essential to creativeness must exist. "In research work, leisure and idleness are not synonymous. The researcher needs some leisure time, free from interruption, to mature his idea, organize his thoughts and reduce his findings to a scientific report." [20] He gave us an insight into the genesis of a scientific paper, when he said, "moments of solitude, with relative freedom from disturbance, are admittedly essential for reflection in a creative mind. The retreat he finds, possibly among some mossy old stone walls, smelly shops, a quiet church corner, or an insect-infested forest, all that would otherwise be a confused medley of stark realism, becomes to him an outer sphere of such rare charm..." [21] In this respect, the scientific temperament is no different from the artistic.

Dean Uichanco bewails the fact that too many times the vestments of science are mistaken for science itself. "Indiscriminate and perhaps superficial gathering of an assortment of data without

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[16] Faculty Conference, University of the Philippines, Baguio, June 19, 1948.
[17] *Philippine Agriculturist*, **25**, 127 (1936).
[18] *Philippine Agriculturist*, **25**, 301 (1936).
[19] Faculty Conference, University of the Philippines, Baguio, June 19, 1948.
[20] *Op. cit.*
[21] *Philippine Agriculturist*, **25**, 213 (1936).

any attempt made at rearranging the facts in order to draw relevant conclusions is not research in a scientific sense. [22] And speaking of statistical methods as aids in rearranging and viewing the facts, he cautioned, "These have been much used by agricultural researchers, to whom they have proved of great value and in many cases a necessity. A warning, however, must be made that not infrequently this treatment often lends the figures a deceitful air of finality which is not really there. The researcher, therefore, should constantly re-examine his results in the sober light of common sense." [23]

He has always maintained a critical attitude towards things and at times, this takes on the aspect of inconsistency; but all he argues for is a balanced outlook, a guarding against bending over too far or learning backwards too much. For instance, on the subject of research laboratory facilities, he said, "Equipments necessary for precision in experimentation and observation, assistants, travel funds for purposes at least of checking up laboratory data with field conditions, reference libraries, and other essential requirements of an up-to-date scientific institution of this nature frequently entail expenses that add up to large sums of money; but these must be considered a good research investment . . ." [24] And yet he recognized that " . . . large funds to draw from, and expensive equipments, although admittedly a great help in the hands of the right individuals are not a prime essential to the pursuit of scientific investigation." [25]

A fundamentalist of the first order, he always argues for basic studies. This, however, does not mean that he is passionately in love with the Ivory Tower to the point of being impractical. He simply wants to emphasize that a broader perspective on day-to-day affairs is afforded to one on top of an Ivory-Tower; and he wants to counteract the tendency of people to be shortsighted. Thus he wrote, "Because of the tangible bounties reaped as a product of research, the idea all too frequently gains ground that the sole justification of scientific work is the expectation of immediate returns. While certain types of research activity may well be pursued from a utilitarian viewpoint, a policy of restriction to this one end will not only unnecessarily inhibit a well-balanced scientific development, but also destroy the prospects of possibly important practical results along

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[22] *Philippine Agriculturist*, **22**, 455 (1933).
[23] Faculty Conference, University of the Philippines, Baguio, June 19, 1948.
[24] *Philippine Agriculturist*, **24**, 809 (1936).
[25] *Philippine Agriculturist*, **22**, 456 (1933).

totally unexpected lines." [26] Proof that he does not regard science for science sake like a child's fondness for play, he maintained that "Popular press release on scientific subjects are extremely valuable. They serve a worthy end in that they help sow among a great body of lay readers the seeds that would develop into a more universal appreciation of scientific work." [27]

Our man has been living a full life reflecting on things and recording his thoughts in the best way a man could. He led an institution with vision, and proved himself a real leader of men. Unmindful of the gallery crowd and the vengeful wrath of little men, he has always acted on the strength of his conviction.

CURRICULUM VITAE

He was born in Calamba, Laguna on April 23, 1894 to Leandro Uichanco y Casañas and Edilberta Bancain Soledad. He attended the elementary school of his town, the Laguna High School (1909), Academy and Junior College of Liberal Arts (1912), College of Agriculture U.P. (BSA, 1915; M.S., 1918) and Harvard University (M.S. 1920; Sc.D. 1922). He was married to Miss Mercedes Alejandro y San Diego in 1924 and they begot five children. He successively held the following positions in the College of Agriculture: Assistant in Entomology (1915-1918), Instructor (1918-1919), U.P. Fellow to U.S. (1919-1922), Assistant Professor (1922-1924), Associate Professor (1924-29), Professor (1929 to date); Acting Head, Department of Entomology (1927-1928), Head (1928-1955); Dean (1939 to date, except for a short period during the Japanese Occupation when he was dismissed for bucking Japanese authority). He is a member of many scientific and honorary societies, representative of his country to many international scientific conferences and was a recipient of many awards, the most significant of which was the President's Distinguished Service Medal as top scientist in 1954. But we can fittingly say with Kipling that with all his honors on, he has not "lost the common touch" and "all men count with him but none too much."

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[26] *National Research Council P.I. Bull.*, **3**, 205 (1935).
[27] *Philippine Agriculturist*, **25**, 637 (1937).

USE OF AMMONIUM SULFATE IN MODIFYING THE MATURITY OF PARENTAL CORN SINGLE CROSSES [1]

I. S. Santos, A. C. de Mesa and B. M. Landicho [2]

The date of pollen shedding of the parental single crosses of the Seed-Board-recommended Philippine Corn Hybrids was hastened by the application of ammonium sulfate by 1.0 day in both dry and wet seasons of 1955-56 and in the wet-season of 1956-57, and by 4.7 days in the 1956-57 dry season. The dates of silking was hastened by 1.4 days in both 1955-56 and 1956-57 wet seasons, by 3.3 days and by 6.7 days in the 1955-56 and 1956-57 dry seasons respectively.

There were no significant differences in acceleration on pollen shedding and silking among the different fertilizer treatments.

The Cuban Yellow Flint single crosses flowered significantly later than the others.

Pollen shedding was generally ahead than silking in all the single crosses studied.

In the production of hybrid corn, heterosis in crosses among inbred lines is very often obtained when unrelated inbred lines are used. It has also been proven by corn breeders that the greatest heterosis in double crosses is obtained when parental single crosses are made up of inbred lines of the same origin. Since inbred lines of diverse origin generally differ in maturity, parental single crosses of most high-yielding double crosses differ considerably in relative period of maturity.

To make the time of flowering of the two parental single crosses of a double cross coincide, the later maturing single cross is planted ahead of the earlier maturing single cross. Here in the Philippines, because of heavy and untimely rains, the planting schedule may not be followed since it might lead to the loss of seed crop. If the two

[1] Central Experiment Station Contribution No. 2015. Based on the theses presented for graduation for the degree of Bachelor of Science in Agriculture from the College of Agriculture on April, 1957 by Amador C. de Mesa and on April, 1958 by Bernardo M. Landicho. Prepared in the Department of Agronomy under the direction of the senior author.

[2] The writers wish to thank Dr. S. C. Salmon, former visiting professor of Plant Breeding and Mr. F. A. Bernardo, Instructor of Plant Breeding for sugnestion on the manuscript. Acknowledgment is also due Mr. S. I. Albano Jr. for help in conducting the experiment.

parental single crosses differing in maturity are planted at the same time and some methods of hastening the flowering of the later maturing parent could be employed, then the hazards of differential planting time could be avoided.

According to Dumenil and Shaw (1952),[3] corn maturity could be accelerated by better fertility processes like better crop rotation practices and the use of manure and commercial fertilizers. They reported that application of manure hastened the maturity of corn by 4 to 10 days on poor rotations and by 2 to 6 days on good rotation. They also found that the addition of small amounts of nitrogen may speed up maturity. Moderate amounts of nitrogen plowed under or sidedressed slightly reduced the moisture content at picking time. Heavy rates such as 80 pounds per acre (89.8 kilograms per hectare) in some cases slightly increased moisture content. In Western Iowa, the application of nitrogen hastened silking from 1 to 5 days.

Miles (1934)[4] reported that nitrogen at the rate of 2 to 6 pounds per acre (2.2 to 6.7 kilograms per hectare) with phosphorus and potassium occasionally hastened tasseling by at most one day but did not shorten the period from flowering to attainment of maximum dry weight.

MacGregor (1953)[5] concluded that maturity of corn was not delayed by heavy applications of nitrogen especially where phosphate and potash were also supplied.

Rather and Tyson (1934)[6] stated that the effect of fertilizers on corn maturity was not significant from the practical standpoint. When the average difference in moisture content between the unfertilized corn and that receiving 200 pounds per acre (225 kilograms per ha.) of 4-16-8 fertilizer was divided by the average moisture loss per day of each variety, it was found that maturity of Michigan 1218 was hastened by 1.6 days; Wisc. 606, by 2.3 days; and Indiana 416, by 2.5 days; all based on three years' data. Likewise, in one year's trial, an application of 200 pounds per acre of 0-0-50 fertilizer delayed the maturity of Michigan 1218 by 4.5 days, that of Wisconsin 606 by 1.7 days, and that of Indiana 416 by 1.4 days.

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[3] L. Dumenil and R. H. Shaw, *Iowa Farm Science*, **6**, 162-164 (1952).
[4] S. R. Miles, *Jour. Am. Soc. Agron.*, **26**, 129-137 (1934).
[5] J. M. MacGregor, *Minnesota Agricultural Experiment Station Report*, **22**, 1-16 (1953).
[6] H. C. Rather and J. Tyson, *Jour. Am. Soc. Agron.*, **35**, 43-47 (1943).

This study was conducted to investigate whether application of large amounts of ammonium sulfate accelerates or delays the flowering of parental corn single crosses. The field experiments were performed from November 1955 to October 1958 at the Central Experiment Station of the U. P. College of Agriculture, College, Laguna.

MATERIALS AND METHODS

The essential features of the experiments were:

Experiment 1 —

Design of experiment: Split-plot
No. of replications: 4
No. of entries or single crosses: 6
Size of plots: 5 × 4.5 meters
Distance between hills: 1 × 0.5 meter
Plants to a hill: 2
Fertilizer: Ammonium sulfate (20-0-0) at 0, 200, 400, and 600 kilograms per hectare

Experiment 2 —

Design of experiment: Split-plot
No. of replications: 5
No. of entries or single crosses: 2
Size of plots: 5 × 4.5 meters
Distance between hills: 1 × 0.5 meter
Plants to a hill: 2
Fertilizer: Ammonium sulfate (20-0-0) at 0, 300, 600, 900, and 1200 kilograms per ha.

The single crosses used in the study were A102 x A103, A102 x A105, A102 x A106, 183 x A113, A111 x A113, and A112 x A113 for experiment 1; A102 x A106 and A112 x A113 for experiment 2. The inbred lines A102, A103, A105, and A106 were derived from the College Flint variety; A111, A112, and A113 from Cuban Yellow Flint variety, and 183 from Eto—1#—1#, a yellow flint inbred line obtained from Colombia, South America through the Rockefeller Foundation. A102 x A103 and 183 x A113 were the parental single crosses of the Seed-Board-recommended Philippine Hybrid #5; A102 x A106 and A112 x A113, of Philippine Hybrid #3; A111 x A113, of Hybrid #1 while A102 x A105 was one of the promising experimental single crosses.

One-half of the amount of fertilizer in each treatment was applied two weeks after planting; the remaining half, a week after the first application. The ring method of application was used in experiment 1 and the band method, in experiment 2. The single crosses served as the main plots, the treatments (rates of fertilizer application) as the subplots. The subplots which consisted of five rows of eight hills each were randomized within the main plots in every replication. With two plants to a hill, the population was 40,000 plants per hectare.

The dry-season crop for experiment 1 was planted on December 9, 1955 and that for experiment 2, on November 30, 1956; the wet-season crops for experiment 1 and experiment 2 were planted on May 14, 1956 and June 6, 1957, respectively.

Three seeds were planted to a hill and later thinned to two plants. The first cultivation was done two weeks after planting followed by hilling-up two weeks after the first cultivation.

The date of pollen-shedding of each subplot was recorded when one-half of the total number of plants were shedding pollen just as the date of silking was taken when one-half of the total number of plants of each subplot had ears starting to show silk.

EXPERIMENTAL RESULTS

Experiment 1

1955-56 Dry-Season

Days to pollen-shedding and to silking. The mean number of days from planting to pollen-shedding and to silking for the 1955-56 dry-season planting is given in table 1. The six single crosses were grouped into two: one was composed of College Yellow Flint single crosses, the other of single crosses made up of Cuban Yellow inbred lines and one Colombian inbred line (183). Single crosses in group 1 obviously matured earlier than those in Group II. For comparing treatment means, the SMD's were included in the tables.

The mean square for treatment was significant for pollen-shedding and highly significant for silking. With the rates employed, ammonium sulfate did not significantly hasten the date of pollen-shedding of the College Yellow single crosses. However, there was an indication that ammonium sulfate applied at the rate of 400 or 600 kilograms per hectare hastened pollen-shedding and silking of the single crosses in group II. Based on the mean of all six single

TABLE 1.—*Mean number of days from planting to pollen-shedding and to silking in the 1955-56 dry-season planting*

SINGLE CROSSES	DAYS TO POLLEN-SHEDDING				SMD		DAYS TO SILKING				SMD	
	kgm. of ammonium sulfate/ha.						kgm. of ammonium sulfate/ha.					
	0	200	400	600	5%	1%	0	200	400	600	5%	1%
	number						*number*					
Group I												
A102 × A103	57.3	57.0	56.3	55.7			64.0	61.0	60.0	59.0		
A102 × A105	55.7	56.7	54.0	55.3			59.3	59.7	57.0	58.0		
A102 × A106	55.3	56.7	56.3	56.7			60.0	60.0	58.7	59.0		
					2.3						2.4	3.3
Group Mean	56.1	56.8	55.5	55.9			61.1	60.2	58.7	58.7		
					1.2						1.4	1.9
Group II												
183 × A113	64.3	64.0	63.0	62.7			71.0	69.3	67.7	67.0		
A111 × A113	68.7	67.0	66.3	66.0			75.3	73.7	72.7	71.3		
A112 × A113	67.0	65.7	65.3	66.3			74.7	70.0	70.7	71.4		
					2.3						2.4	3.3
Group mean	66.7	65.6	64.9	60.0			73.7	71.0	70.0	69.9		
					1.2						1.4	1.9
Treatment mean	61.4	61.2	60.2	60.5			67.4	65.6	64.5	64.1		
					1.0						1.0	1.4

crosses, ammonium sulfate applied at the rate of 400 or 600 kilograms per hectare significantly accelerated pollen-shedding and silking.

The mean square for treatment was significant for pollen-shedding and highly significant for silking. With the rates employed, ammonium sulfate did not significantly hasten the date of pollen-shedding of the College Yellow single crosses. However, there was an indication that ammonium sulfate applied at the rate of 400 or 600 kilograms per hectare hastened pollen-shedding and silking of the single crosses in group II. Based on the mean of all six single crosses, ammonium sulfate applied at the rate of 400 or 600 kilograms per hectare significantly accelerated pollen-shedding and silking.

1956 Wet Season

Days to pollen-shedding and to silking. The mean number of days from planting to pollen-shedding and to silking in the 1956 wet season are presented in table 2. The mean squares for treatment were both highly significant.

For group 1 single crosses and group II single crosses, pollen-shedding and silking were significantly hastened by the application of ammonium sulfate at the rate of 600 kilograms and 400 kilograms per hectare respectively. Based on the means of six single crosses, pollen-shedding was significantly accelerated by the application of ammonium sulfate at the rate of 400 and 600 kilograms per hectare.

Single cross means in the 1956 Wet-Season planting. On the average, the group I crosses shed pollen about five days and silked about four days earlier than the group II single crosses. The single crosses A111 x A113 and A112 x A113 matured significantly later than the others.

Summary of Pollen-Shedding and Silking in Both Seasons (1955-56 Dry and 1956 Wet)

Table 3 summarizes the data on the number of days from planting to pollen-shedding and to silking in the 1955-56 dry-season and 1956 wet-season plantings. Acceleration on pollen-shedding and silking was determined by getting the difference between the value for the control and the value for the 600-kilogram-per-hectare treatment in most cases. When the value for the 600-kilogram-per-hectare

TABLE 2.—*Number of days from planting to pollen-shedding and to silking in the 1956 Wet-season planting*

SINGLE CROSSES	DAYS TO POLLEN-SHEDDING				SMD		DAYS TO SILKING				SMD	
	kgm. of ammonium sulfate/ha.						kgm. of ammonium sulfate/ha.					
	0	200	400	600	5%	1%	0	200	400	600	5%	1%
	number						*number*					
Group I												
A102 × A103	44.8	44.3	44.3	44.3			48.0	46.5	48.8	46.8		
A102 × A105	46.0	45.8	45.5	44.4			48.0	47.5	47.5	46.8		
A102 × A106	46.0	44.5	44.8	44.8			48.0	46.0	46.0	46.0		
					1.0	1.3					1.2	1.6
Group mean	45.6	44.9	44.9	44.5			48.0	46.7	47.4	46.5		
					0.5	0.7					0.7	
Group II												
183 × A113	48.3	47.8	47.5	47.8			49.3	48.8	48.5	58.8		
A111 × A113	51.8	50.5	49.8	50.3			53.8	51.8	51.8	51.3		
A112 × A113	50.3	49.8	49.5	49.8			52.0	51.3	51.5	50.8		
					1.0	1.3					1.2	1.6
Group mean	50.1	49.4	48.9	49.3			51.7	50.6	50.3	50.3		
					0.5	0.7					0.7	
Treatment mean	47.8	47.1	46.9	46.9			46.9	48.7	48.9	48.4		
					0.4	0.6					0.5	0.7

TABLE 3.—*Summary of data on number of days from planting to pollen shedding and to silking in the 1955-56 dry-season and 1956 wet-season plantings*

SINGLE CROSSES	DAYS TO POLLEN-SHEDDING						DAYS TO SILKING					
	1955-56 dry			1956 wet			1955-56 dry			1956 wet		
	0	600	dif.	0	600	dif.	0	600	dif.	0	600	dif.
Group I												
A102 × A103	57.3	55.7	1.6	44.8	44.3	0.5	64.0	59.0	5.0	48.0	47.4[b]	0.6
A102 × A105	55.7	55.3	0.4	46.0	44.4	1.6	59.3	57.5[a]	1.8	48.0	46.8	1.2
A102 × A106	55.3	56.6[b]	1.3	46.0	44.7[b]	1.3	60.0	48.9[a]	1.1	48.0	46.0	2.0
Group mean	56.1	55.9	0.2	45.6	44.5	1.1	61.1	58.5	2.6	48.0	46.7	1.3
Group II												
183 × A113	64.3	62.7	1.6	48.3	47.7[a]	0.6	71.0	67.0	4.0	49.3	48.7[a]	0.6
A111 × A113	68.7	66.0	2.7	51.8	50.1[a]	1.7	75.3	71.3	4.0	53.8	51.3	2.5
A112 × A113	67.0	65.8	1.2	50.3	49.7[a]	0.6	74.7	70.7[b]	4.0	52.0	50.7[a]	1.3
Group Mean	66.7	64.8	1.8	50.1	49.2	1.0	73.7	69.7	4.0	51.7	50.2	1.5
Mean	61.4	60.4	1.0	47.8	46.8	1.0	67.4	64.1	3.3	49.9	48.5	1.4

[a] Mean value for 400 and 500 kilograms per hectare.
[b] Mean value for 200, 400 and 600 kilograms per hectare.

treatment was higher than that for the 400-kilogram treatment these two values were averaged. When value for the 600-kilogram was higher than that for the 200-kilogram treatment, the values for the 200, 400, and 600 kilogram treatments were averaged. These average values were used instead of the values for the 600-kilogram-per-hectare treatment.

From the group I single crosses the mean maximum acceleration obtained in days to pollen-shedding was 0.2 day in the dry season and 1.1 days in the wet-season; in the group II single crosses, it was 1.8 days in the dry season and 1.0 day in the wet season.

For the group I single crosses the mean maximum acceleration obtained in days to silking was 2.6 in the dry season and 1.3 days in the wet season; for the group II single crosses, it was 4.0 days in the dry season and 1.5 days in the wet-season.

Experiment 2
1956-57 Dry Season

Days to pollen-shedding and to silking. The mean square for treatment (table 4) was highly significant, showing that pollen-shedding was significantly hastened by the application of ammonium sulfate from 300 to 1200 kilograms per hectare. In the single cross A102 x A106, the application of 300 kilograms per hectare reduced the number of days to pollen-shedding by four days. Increasing the rate of fertilizer treatment to 600, 900, and 1200 kilograms per hectare, the days to pollen-shedding did not significantly differ from the 300-kilograms treatment.

The pollen-shedding of A112 x A113 was also hastened significantly by about four days by the application of 300 kilograms of ammonium sulfate per hectare. With the rate of 600 kilograms per hectare, it was further hastened by two days or about six days earlier than the unfertilized treatment. Increasing the rate of application from 600 to 900 and to 1200 kilograms per hectare showed no decided acceleration.

The treatments with ammonium sulfate (300, 600, 900, and 1200 kilograms per hectare) shortened significantly the number of days to silking by six days.

1957 Wet Season

Days to pollen-shedding and to silking. The pollen-shedding for

TABLE 4.—*Number of days from planting to pollen-shedding and to silking in the 1956-57 dry-season planting*

SINGLE CROSSES	DAYS TO POLLEN-SHEDDING kgm. of ammonium sulfate/ha.					SMD		DAYS TO SILKING kgm. of ammonium sulfate/ha.					SMD	
	0	300	600	900	1200	5%	1%	0	300	600	900	1200	5%	1%
A102 × A106	59.0	55.0	56.0	55.2	55.4			62.8	56.6	57.4	56.4	56.4		
A112 × A113	67.0	62.6	60.6	60.8	60.4			72.8	67.2	64.8	64.6	64.2		
						1.57	2.10						1.92	2.57
Treatment mean	63.0	58.8	58.3	58.0	57.9			67.8	61.9	61.1	60.5	60.3		
						1.10	1.47						1.35	1.80

TABLE 5.—*Number of days from planting to pollen-shedding and to silking in the 1957 wet-season planting*

SINGLE CROSSES	DAYS TO POLLEN-SHEDDING kg. of ammonium sulfate/ha.					SMD		DAYS TO SILKING kg. of ammonium sulfate/ha.					SMD	
	0	300	600	900	1200	5%	1%	0	300	600	900	1200	5%	1%
A102 × A106	52.4	50.4	50.6	50.8	51.0			53.4	52.0	51.2	52.2	51.8		
A112 × A113	54.8	54.8	54.8	54.6	54.8			56.4	56.0	55.8	56.4	56.6		
						0.07	1.43						1.26	1.70
Treatment mean	53.6	52.6	52.6	52.8	52.9			54.9	54.0	53.5	54.3	54.2		
						0.75	1.01						0.89	1.19

both single crosses was not significantly hastened by the application of ammonium sulfate (table 5). The number of days to silking for single cross A102 x A106 was significantly reduced by all rates of fertilizer treatment. The fertilizer rates of 300, 600, 900, and 1200 kilograms per hectare did not differ significantly in their effect on the number of days to silking.

Single cross A112 x A113 did not show any response to ammonium sulfate treatments while single cross A102 x A106 flowered about four days earlier.

Summary on Pollen-Shedding and Silking in Both Seasons of Planting

The mean maximum acceleration obtained on pollen-shedding for single cross A102 x A106 was 3.0 in the dry-season and 1.8 days in the wet season, for single cross A112 x A113, 6.4 days in the dry-season and 0.2 day in the wet season (table 6).

For single cross A102 x A106, the mean maximum acceleration on silking was 5.4 days in the dry-season and 2.2 days in the wet-season; for single cross A112 x A113, 8.0 days in the dry season and 0.6 day in the wet season.

DISCUSSION AND CONCLUSION

Summarizing the results for the years 1955-56 and 1956-57, table 7 shows that pollen-shedding of A102 x A106 was hastened by 1 to 2 days and silking by 2 days in the wet-season with the application of 600 kilograms of ammonium sulfate per hectare. However, the same application did not hasten significantly pollen-shedding and silking of A112 x A113.

The results in the dry-season of 1955-56 and 1956-57 varied. Only the 1956-57 dry-season test showed marked differences in the number of days to pollen-shedding and to silking between the unfertilized and the fertilized treatments. The writers are of the opinion that the hastening of pollen-shedding by 6.4 days and silking by 8 days in 1956-57 dry season plantings is not only due to the fertilizer but also to other factors such as insufficient moisture (Fig. 1). It was observed that plants of the unfertilized treatment were stunted which might have contributed to the delay in flowering of the four experimental plantings made. This tends to indicate that the application of ammonium sulfate had only a limited effect in hastening pollen-shedding and silking. High rates of application failed to hasten further the date of flowering.

TABLE 6.—*Summary of data on number of days from planting to pollen-shedding and to silking in the 1955-56 dry-season and 1956 wet-season plantings*

SINGLE CROSSES	DAYS TO POLLEN-SHEDDING						DAYS TO SILKING					
	1956-57 Dry-Season			1957 Wet-Season			1956-57 Dry-Season			1957 Wet-Season		
	0	600	dif.	0	600	dif.	0	600	dif.	0	600	dif.
A102 × A106	59.0	56.0	3.0	52.4	50.6	1.8	62.8	57.4	5.4	53.4	51.4	2.2
A112 × A113	67.0	60.6	6.4	54.8	54.6	0.2	72.8	64.8	8.0	56.4	55.8	0.6

TABLE 7.—*Average number of days from planting to flowering of the unfertilized and the fertilized (600 kg/ha.) plants in both seasons of 1955-56 and 1956-57*

SINGLE CROSSES	YEAR	DAYS TO POLLEN-SHEDDING						DAYS TO SILKING					
		Dry-Season			Wet-Season			Dry-Season			Wet-Season		
		0	600	diff.	0	600	diff.	0	600	diff.	0	600	diff.
			days			*days*			*days*			*days*	
A102 × A106	1955–56	53.3	56.7	1.4	46.0	44.8	1.2	60.0	59.0	1.0	48.0	46.0	2.0
	1956–57	59.0	56.0	3.0	52.4	50.6	1.8	62.8	57.4	5.4	53.4	51.2	2.2
A112 × A113	1955–56	67.0	66.3	0.7	50.3	49.8	0.5	74.7	71.4	3.3	52.0	50.8	1.2
	1956–57	67.0	60.6	6.4	54.8	54.6	0.2	72.8	64.8	8.0	56.4	55.8	0.6

Under conditions similar to those present in the 1955-56 dry-season and 1956 wet-season plantings, the single cross A102 x A103 of the Philippine Hybrid No. 5 (183 x A113) (A102 x A103) could be used as the seed parent in a simultaneous planting of the single crosses. In such case, the silking of A102 x A103 would coincide with the pollen-shedding of 183 x A113. An extra amount of 200 kilograms of ammonium sulfate per hectare applied to 183 x A113 can induce pollen-shedding at the time A102 x A103 is at the height of silking.

For Philippine Hybrid No. 3, the scheme just described would not work very well. Under conditions similar to those in the 1955-56 dry-season planting, the difference between the number of days to silking of A102 x A106 and the number of days to pollen-shedding of A112 x A113 would be about 7.0 days when these single crosses are planted at the same time. Even with the application of 600 kilograms of ammonium sulfate per hectare, the date of pollen-shedding of A112 x A113 would be hastened by about 1.2 days only, provided no ammonium sulfate is applied to A102 x A106. Nevertheless, there would be still a gap of 4.8 days between the date of silking of A102 x A106 and the date of pollen-shedding of A112 x A113. Moreover, the results of the 1956-57 dry season planting show that with a rate of 300 kilograms per hectare of the same fertilizer applied to A112 x A113, the date of pollen-shedding was only 0.2 day earlier than the date of silking of the unfertilized A102 x A106 (table 4).

Under conditions similar to that of the 1956 wet-season planting, seed production of the Philippine Hybrid No. 3 would be simpler than that under conditions obtained in the 1955-56 dry-season planting. The difference between the number of days to silking of A102 x A106 and the number of days to pollen-shedding of A112 x A113 when no fertilizers were applied was about 2.3 days. A hastening effect on pollen-shedding of about 0.6 day was caused by the application of 400 to 600 kilograms of ammonium sulfate to A112 x A113, leaving a difference of about 1.7 days more.

However, in the wet-season planting of 1956-57 the difference between the number of days to pollen-shedding and the number of days to silking of these single crosses was 1.4 days. With the application of 600 kilograms of ammonium sulfate to A112 x A113 acceleration on pollen-shedding was 0.2 day, the net difference being 1.2 days. As long as no source of contaminating pollen is nearby, these differences are not serious since corn silk remains alive and

receptive for seven days after emergence. As long as the seed parent silks before the pollen parent sheds pollen, the two parental single crosses may be planted at the same time in the double crossing field with or without the aid of "hasteners", like ammonium sulfate. Provided that the net difference is not more than five to seven days, the technique just discussed and described would seem feasible to use, since the function of the "hasteners" would be to reduce the difference between the date of silking of the seed parent and the date of pollen-shedding of the pollen parent as much as possible so as to reduce the dangers of pollen contamination from nearby corn fields.

The mean effect of ammonium sulfate for modifying maturity of the six parental single crosses shows that the date of pollen-shedding was hastened by 1.0 day in both dry and wet seasons of planting. The number of days from planting to pollen-shedding in the control was 61.4 days in the 1955-56 dry-season planting and 47.8 days in the 1956 wet-season planting.

The date of silking was hastened by 3.3 days in the 1955-56 dry-season planting when the mean number of days from planting to silking in the control was 67.4 days; and 1.4 days in 1956 wet-season planting when the mean number of days from planting to silking was 49.9 days.

The date of pollen-shedding of the fertilized plots was accelerated by a maximum of 4.7 days in the 1956-57 dry-season planting when the mean number of days from planting to pollen-shedding in the control was 63.0 days; and only a maximum of 1.0 day in the 1957 wet-season when the mean number of days from planting to pollen-shedding in the control was 53.6 days.

The silking of the fertilized plots was hastened by a maximum of 6.7 days in the 1957 dry-season planting when the mean number of days from planting to silking in the control was 67.8 days; and 1.4 days in the 1957 wet-season when the mean number of days from planting to silking in the control was 54.9 days.

There were no significant differences in acceleration on pollen-shedding and silking among the 300, 600, 900, and 1200 kilogram applications of ammonium sulfate.

The single cross A102 x A106 flowered about 4 days earlier than single cross A112 x A113.

EFFECT OF FOUR YEARS OF CROPPING TO CORN WITH AND WITHOUT FERTILIZATION ON THE NUTRIENT STATUS OF LIPA CLAY LOAM [1]

S. N. Tilo, N. B. Nazareno, B. A. Azucena Jr., and N. L. Galvez

The yearly increments in yield of corn in Lipa clay loam were higher with the application of the first 45 kg. N than with the second 45 kg. N.

Two applications of 90 kg. P_2O_5 per hectare per year over a period of four years has built up both the total and available P_2O_5 of the soil. Exchangeable potassium has not been increased by two applications of muriate of potash per year.

The amount of organic matter has not been changed by continuous cropping with and without the use of fertilizers over a period of four years.

The development of soil acidity was a slow process in Lipa clay loam and was accelerated with increased rates of nitrogen application.

Lipa clay loam is a residual soil formed from the weathering of volcanic tuff under a rainfall of 2233 mm. during the wet season and 244 mm. during the dry season in the areas around Mt. Maquiling. This soil can support the growth of both seasonal and perennial lowland and upland crops under favorable climatic conditions.

While there are enough data to show that Lipa clay loam has to be applied with nitrogen to produce substantial crop yields, data regarding its ability to stand the impact of continuous cropping to corn with and without fertilizers are very limited. The information that can be gained from a study of long duration involving fertilizer use will be valuable to farmers who practice continuous cropping. Furthermore, the data can be used in outlining a program for the release of government lands for settlement. It is probable that if yields from the present area which is devoted to agricultural production can be maintained through judicious application of fertilizers, the indiscriminate use of forests for "kaingins" may be minimized.

In an earlier paper (Tilo, 1957) the effect of fertilization on the nutrient levels of Lipa clay loam over a two-year period was reported. Four corn croppings with and without treatment of dif-

[1] Central Experiment Station Contribution No. 2016.

ferential fertilizer over a period of two years have not changed the organic matter, available phosphorus and pH value of the soil. The application, however, of muriate of potash has increased the amount of exchangeable potash. Nitrogen was the main factor in increasing corn production.

It would be of interest, therefore, to know the nutrient status of this soil after four years of continuous cropping with and without the use of fertilizers; hence the sustained study of which the present paper is a report.

MATERIALS AND METHODS

The details of the field experiment were described in an earlier paper (Tilo, 1957).

The chemical analysis of the soil was carried out on samples collected from the 0-6 inch layer with the use of a sampling tube. Ten cores taken at random from each plot were mixed thoroughly, air-dried, pulverized and sieved through a 2-mm. screen.

Total phosphorus was determined by digesting the sample with perchloric acid. The digest was dissolved with distilled water and an aliquot was used in the colorometric determination of phosphorus by the development of the molybdophosphoric acid blue color (Jackson, 1958). Available phosphorus was determined by the Truog method (1930).

Exchangeable potassium was obtained by displacement with N NH_4Ac (pH 7.0) and determined with a Beckman direct reading flame photometer.

Oxidizable organic matter was determined by the use of the dichromate method and pH, and by the use of a Beckman pH meter with the glass electrode in the soil suspension in water, 1:1 (Peech, M, *et al.*, 1957).

Yields.—The analysis of the data from each individual planting showed no response from phosphate and potash fertilization. The discussion will be confined, therefore, to the effects of nitrogen alone.

In table 1, it will be noted that the yield of corn at the beginning of the experiment was 39.4 cavans at O N, 75.2 cavans at 45 N, and 85.3 cavans at 90 N. The 39.4 cavans yield at O N, which

TABLE 1.—*Mean yield of corn grains in cavans* per hectare (15% moisture) for the wet and dry seasons in each of five years as affected by nitrogen applied to a Lipa clay loam*

TREATMENT	54 W	54 D	55 W	55 D	MEAN OF 2 YRS.	56 W	56 D	57 W	57 D	58 W	58 D	MEAN OF 3 YRS.
0	39.4	19.9	22.3	20.4	25.5	19.1	**	35.1	**	44.6	**	32.9
45	75.2	46.6	55.0	42.1	54.7	42.3		37.3		57.7		45.8
90	85.3	54.3	65.8	44.7	62.5	50.4		33.1		53.9		45.8
Season mean	66.6	40.3	47.7	35.7	47.6	37.3		35.1		52.0		41.5

* One cavan = 56 kilograms.
** Crop failed.

TABLE 2.—*Mean yearly yield increments of corn grain (cav./ha.)*

TREATMENT	54 W	54 D	55 W	55 D	MEAN OF 2 YRS.	56 W	56 D	57 W	57 D	58 W	58 D	MEAN OF 2 YRS.
1st 45 kg N	35.8	26.7	32.7	21.7	29.2	23.2	**	2.2	**	13.1	**	12.9
2nd 45 kg N	10.1	7.7	10.8	2.6	7.8	8.1		–4.2		–3.8		0

* One cavan = 56 kilograms.
** Crop failed.

is much higher than the average yield of corn in the Philippines, is attributed to the two-year fallowing and planting of mungo before the preparation of the land. The planting thereafter showed declining yields up to the 1956 wet season and then gradually increased especially after crop failures. The yield of corn following the crop failures in the dry season of 1956 was 35.1 cavans and that following the crop failure in the dry season of 1957, 44.6 cavans per hectare. These results disclose the fact that the effect of crop failures is similar to that of land fallowing; i.e. that original soil fertility is restored.

The yield increments due to nitrogen differentials were higher with the first 45 kg. nitrogen than with the second 45 kg. nitrogen (table 2).

Total P_2O_5 (table 3, A).—In the no phosphorus plot (-0-0) the amount of total P_2O_5 ranges from 1625 to 1917 ppm. The lowest was exhibited by the plot which received the highest amount of nitrogen and the highest, by the control plot.

This strongly suggests that a soil, which is initially responsive to nitrogen and not to phosphorus, may, upon successive application of nitrogen, deplete more rapidly its phosphorus content than the unfertilized lot and sooner or later would show the need for combining phosphorus in the nitrogen applications.

On the other hand, the plots which received an amount of P_2O_5 equivalent to 720 kg. per hectare (-90-0) in a period of 4 years did not show any result parallel to that of the no phorphorus plot. Even if the nitrogen plots contained lower amounts of total P_2O_5 than the control, the amount of P_2O_5 did not decrease with the rates of nitrogen application. At 45 kg. N level, the amount of P_2O_5 was lower than that at 90 kg. N level.

The plot which has been given both P_2O_5 and K_2O (-90-90) showed results which had no resemblance either with no-phosphorus or with phosphorus plot.

At overall nitrogen levels, the application of 720 kg. P_2O_5 per hectare over a period of four years increased the total P_2O_5 of the soil by 201 ppm. The combined application of 720 kg. of P_2O_5 and K_2O showed an increase of only 109 ppm.

Increasing rates of nitrogen fertilization which was accompanied by a corresponding increase in crop yields and likewise by a higher

amount of nutrient removal, was indicated by the mean values of total P_2O_5. At O N, the soil contained 1924 ppm; at 45 N, 1868 ppm; at 90 N, 1813 ppm.

Available P_2O_5 (table 3, B).—The amount of available P_2O_5 corroborates the finding that the application of 720 kg. P_2O_5 over a period of four years in connection with corn production increases the phosphorus content of the soil. The trend of results of the individual treatment is parallel to that of the total phosphorus content of the soil.

Exchangeable potassium (table 3, C).—The amount of exchangeable potassium of the soil was not affected by the application of either phosphorus or potassium fertilizers. The use of nitrogen fertilizers, however, tended to decrease the amount of exchangeable potassium with increasing rates of nitrogen. The treatments -0-0, -90-0, and -90-90 showed the effects of fertilizer on the amount of exchangeable potassium in the soil: they decreased with increasing rates of nitrogen.

Organic matter (table 3, D).—It is apparent in the table that four years of continuous corn planting with and without the use of fertilizers did not change the organic matter content of the soil. However, the great response from the application of nitrogen fertilizers

TABLE 3.—*The effects of continuous cropping and fertilizer applications on Lipa clay loam after four years.*

A. Total phosphorus * (ppm)

N-LEVELS	PK-COMBINATIONS -0-0	-90-0	-90-90	MEAN
0	1917	2000	1854	1924
45	1750	1938	1917	1868
90	1625	1958	1854	1813
Mean	1764	1965	1873	

* Analysis made on a composited sample of four replications.

B. Available phosphorus (ppm)

0	68.90	91.49	64.31	74.89
45	57.62	71.58	68.12	65.77
90	52.44	75.02	51.68	59.72
Mean	59.65	79.36	61.37	

C.V. (PK combinations) 4.1%
C.V. (N-levels) 6.3%

C. Exchangeable potassium (ppm)

0	569.5	514.5	515.0	533.0
45	436.5	472.0	444.5	451.0
90	388.0	421.0	413.5	407.5
Mean	464.6	469.2	457.7	

Differences not significant
C.V. (PK combinations) 8.2%
C.V. (N-levels) 17.2%

D. Organic matter (per cent)

	PK-COMBINATIONS			MEAN
	-0-0	-90-0	-90-90	
0	1.86	1.88	1.77	1.84
45	1.89	2.02	1.89	1.98
90	1.92	1.93	1.76	1.87
Mean	1.89	1.94	1.81	

Differences not significant.
C.V. (PK-combinations) 11.1%
C.V. (N-levels) 3.6%

E. Soil pH

	PK-COMBINATIONS			MEAN
	-0-0	-90-0	-90-90	
0	6.0	5.8	6.2	6.00
45	5.7	5.9	6.0	5.86
90	5.4	5.6	5.8	5.60
Mean	5.70	5.76	6.00	

Significant difference at 5% probability level
PK-comb. 0.29
N-levels 0.40
C.V. 2.3%

highly suggested the inability of the native soil organic matter to provide the corn plants with sufficient amount of available nitrogen, also that under Philippine climatic conditions, continuous planting of corn would not build up the organic matter of the soil. Crop rotation, therefore, should be considered.

Soil pH (table 3, E).—At overall rates of nitrogen, there is a tendency for pH to increase. At treatments -90-0, and -90-90, the increases in pH over treatment -0-0 are 0.06 and 0.30 unit, respectively. However, only the increase of 0.30 unit is significant.

On the other hand, the pH values in the P and PK treatments are apparently associated with the rates of nitrogen. At O N, the pH is 6.0; at 45 kg. N, 5.86; at 90 kg. N, 5.60. Similar results were reported by Tilo (1957). The present results, unlike the first two years data, show significant decrease in pH. This is indicated by the difference in pH values between the O N and 90 kg. N plots. These results show that the development of soil acidity from continuous corn cropping with nitrogen fertilization was a slow process in Lipa clay loam with clay content dominantly montmorillonitic clay interstratified with illite-vermiculite and intergradational vermiculite-chlorite amorphous ferro-allophane-like minerals (Galvez, 1957).

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A STUDY ON SOME PHYSICAL AND CHEMICAL CHARACTERISTICS OF BERKSHIRE BOAR SEMEN INCLUDING EFFECTS OF ATMOSPHERIC TEMPERATURE AT COLLECTING TIME [1]

E. Wagelie, G. Garcia and J. Capinpin [2]

The semen of the seven normal Berkshire boars varied in color from gray to milky-white; the higher the sperm concentration the lighter the color of the semen. The properties of the semen collected at one-day intervals generally did not differ significantly from those of the semen collected at four-day intervals. Their respective averages are as follows: life duration under laboratory conditions, 9 hrs. + 37 min. and 9 hrs. + 40 min., sperm concentration, 198,429 and 219,871 sperms per cu. mm.; pH, 7.42 and 7.41; methylene blue reduction time, 6'6" and 6'32"; and per cent live sperm, 66.10 and 67.82.

Neither the volume of semen produced, its concentration nor percentage of live spermatozoa is correlated with the atmospheric temperature at the time of collection. However, positive correlations were obtained between temperature and motility of spermatozoa, and between initial motility and the methylene blue reduction time for most boars.

Six common types of sperm abnormalities recorded were headless, tailless, coiled tail, pyriform sperm, shoe-hooked and protoplasmic droplet on the middle piece. The less common abnormalities were two-headed, giant head and two-tailed spermatozoa. There was an apparent increase in abnormal spermatozoa with shipment of semen from Manila to Los Baños.

Artificial insemination of swine and other livestock is one way to accelerate the production of food animals. Perhaps, its greatest advantage over natural breeding is the extension of the use of selected sires. A single ejaculate can be used to inseminate five to six sows, whereas in natural breeding it can serve only one. In addition, it permits the adequate probing of sires at an earlier age, reduces the cost of feeding and housing the sire, lessens the possibility of spreading genital diseases, and overcomes various handicaps to suc-

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cessful mating such as great difference in size. It also makes possible more extensive and satisfactory studies of the problems of fertility.

Although a powerful implement for herd improvement, artificial insemination is a dangerous one if the influence of low-quality males is widely disseminated or if an infectious disease is spread as a result of careless technique.

The sperm cells are highly sensitive, and their nature and characteristics must be understood if the best results are to be obtained. The physical and chemical properties of boar semen, including any effects of air temperature on these properties, should be studied and determined because they are important factors to consider in artificial insemination.

This study was made with the hope of contributing data for accurate evaluation of freshly drawn semen and assessment of its potential fertilizing capacity by (1) studying Berkshire boar semen with respect to volume of ejaculate, concentration of spermatozoa per cu. mm., morphology, pH value, motility, and percentage of live and dead sperms and (2) determining the effects, if any, of atmospheric temperature at the time of collection on the abovementioned characteristics of the semen.

The work was conducted from January to March, 1958 in the Bureau of Animal Industry, Manila where semen collections and initial examinations were made and in the U.P. College of Agriculture, College, Laguna where further examinations of the semen were conducted.

REVIEW OF LITERATURE

Preliminary studies.—Artificial insemination is practised extensively on cattle in some parts of the world. Spalding, Castillo, and Montemayor (1958) reported that more than 70 per cent of the cattle in Denmark and about 25 per cent of the cattle in the United States are bred artificially. Artificial insemination is also practised extensively in Great Britain, Russia, and Japan.

The artificial breeding of swine, however, is comparatively of recent introduction elsewhere and in the Philippines. As a matter fact, studies on boar semen for artificial breeding are very much limited compared with those on bull semen. Artificial breeding of swine started in this country after the last war when Coronel (1947)

of the Bureau of Animal Industry, made a preliminary study of the feasibility of utilizing the procedure in the swine breeding program of the Bureau.

Coronel concluded that the stage of oestrum at the time of artificial insemination was an important factor in determining the rate of conception. Successful impregnations were obtained when the sows were inseminated on the second to the fourth day of the heat period. He further reported that the volume of semen did not always determine the number of offspring and that the ratio of male to female offspring obtained in artificial insemination was the same as that obtained in natural breeding.

Noll (1948) studied the longevity of sperm cells of boars and reported that good motility could be maintained for six hours at room temperature after which there was a rapid decline, with the death of the spermatozoa occurring between the sixteenth and twentieth hours. He also reported on the length of time boar spermatozoa would live in different media under different conditions. He found that the egg yolk-sodium citrate sulfanilamide diluent (50 cc egg yolk and 50 cc sodium citrate with 300 mg. sulfanilamide) gave better results than other extenders and maintained a longevity range of 11 to 12 days.

Mondoñedo (1936) undertook a study on the reproductive organs of the male Berkjala pig with special reference to spermatogenesis; and in another study Rodolfo (1934a) reported three types of recognized abnormalities in boar sperm, including the liquid and gel substances found in it. The three types of sperm cell abnormalities he cited were: type 1, which had no protoplasmic drop; type 2, where the drop was on the neck; and type 3, where the drop was toward the middle of the tail. He believed that these types represented successive stages in the development of the spermatozoa. All the sperm cells in the proximal end of the epididymis were of type 2 and were transformed into type 3 and finally into type 1 which was the predominant type. He further found that motility was greatest in type 1 and least in type 3. Type 2 spermatozoa found in the proximal end of the epididymis were nonmotile.

Frequency of collection.—Hale *et al.* (1933) found that repeated semen collection trials in bulls, with an average of four collections per trial, caused a drop in semen quality, and that the semen was back to normal within one week after the trials were stopped.

Buharin and Poboda (1946) used bulls twice daily for 15 days followed by a rest period of one or two days, and obtained satisfactory results.

According to McKensie, Miller, and Bauguess (1938), the volume of semen of boars was not reduced by services at 48-hour interval, but a marked drop occurred when services were at 12-hour interval. They found no direct relationship between liveweight and semen volume, between total number of spermatozoa and semen volume, or between duration of ejaculation and semen volume. Of the five boars studied, four ejaculated a daily average of 20 billion spermatozoa for several days. Another boar, which was sexually vigorous, gave 33 billion sperm cells daily for 14 days.

According to the findings of Rodolfo (1934c), it is doubtful if more than one collection or service may be allowed daily in the case of yearling boars without lowering semen quality. A better practice would be to collect once every two days.

Warbritton and associate (1937) found that when two ejaculates were taken from a bull once daily for 57 days, the volume of semen was well maintained. However, the sperm cell concentration varied from 2179 million per cubic centimeter at the start of the fourth week to none at the beginning of the ninth week.

Gun (1936), as cited by Warbritton and associate (1937), reported that the semen of rams which ejaculated as often as 8 times in 10 days and 17 times in 45 days showed no radical decrease in the duration of motility of the sperm cells, in the percentage of active spermatozoa or in volume. Neither were the morphological characteristics of the cells affected.

Lambert and McKensie (1940) reported that rams could stand three and, in some cases, even more matings daily during the breeding season without apparent injury to their breeding power.

Bratton and co-workers (1954) showed that in bulls one ejaculation every four days or two ejaculations every eight days did not reduce fertility during a trial of one year, and that two ejaculates every eight days yielded 60 per cent more spermatozoa than ejaculation once in eight days.

Van de Mark *et al.* (1955) found no reduction in libido or semen quality in a bull which ejaculated three times a day for three years.

In 1952, Skatkin working on horse semen, found no decrease in the number of spermatozoa from two services a day for one week. Only in those animals on an unbalanced ration was there a marked decrease in density of the sperm when the number of services was raised three to four times for three to four days a week.

Temperature, season, and motility.—Swanson and Herman (1941) stated that the physical and chemical characteristics which have been commonly proposed for the evaluation of semen are pH, concentration, motility, and percentage of live spermatozoa.

Kumaran (1951) found the breeding record of the sire to be a valuable criterion in the evaluation of semen quality. He also found that the influence of environmental factors on semen varied considerably with the amount of semen produced, its quality, and its fertility.

Erb, Andrews, and Hilton (1942) observed that the analysis of variance of various characteristics of semen in relation to bulls and to months showed highly significant differences between bulls and between months for all characteristics except the pH.

Donham *et al.* (1931), as cited by Swanson and Herman (1941), found that semen below normal in motility was less than half as effective in producing conception as was semen of normal or 80 per cent motility.

Erb and associates (1942), working on bulls in Indiana, obtained semen of lowest quantity and quality in July, August, and September and semen of highest quantity and quality in April, May, and June.

Lewis (1911) kept boar spermatozoa motile for 15 to 25 hours at 30°C. He found that the cells remained motile longer at lower temperature and that sunlight was detrimental to their vitality. According to him, there was the probability of poor breeding qualities in semen with low sperm cell motility.

Anderson (1938) suggested that more attention should be paid to the degree of motility and that the survival period of spermatozoa *in vitro* might perhaps provide a more reliable index of fertility.

Phillips, Schoot, Terrill, and Gildon (1939) worked on the use of shipped ram semen. During three breeding seasons, ewes were

inseminated with semen kept in vacuum bottles. The semen was shipped by air express from Dubois, Idaho to Moscow, Idaho (700 miles) and from Beltsville, Maryland to Dubois, Idaho (2250 miles). The period of transit ranged from 19 to 24 hours, or an average of 35 hours. The temperature in the vacuum bottles on arrival ranged from 0.5 to 9.0°C. Upon arrival the semen was stored in refrigerators at about 5°C., and when used later for artificial breeding it gave successful results.

pH of semen.—Shergin (1935) stated that the semen of the majority of the animals possessed weak alkalinity. The pH values of the semen of bull, ram, rabbit, stallion, boar, human being, and duck which were determined electrolytically with a quinhydrone electrode were 6.74, 7.08, 7.20, 7.23, 7.57, 7.79, and 7.25, respectively. The sperm was acid or nearly so, when strong glycolysis occurred.

Reid, Ward, and Salisbury (1948) found highly significant correlation coefficients between the change in pH and other characteristics of semen. The data obtained by these workers were: concentration of spermatozoa, 0.46 per cent; initial motility of spermatozoa, 0.44 per cent; viability of spermatozoa, 0.21 per cent; and morphologically abnormal spermatozoa, 0.32 per cent. They also concluded that the change in pH affected by incubation was probably the quickest, simplest, and best known test of semen quality.

Morphological abnormalities.—In a morphological study of boar semen, Philips (1935) concluded that the sperm cell morphology of a boar could be taken as an indication of fertility. Semen from fertile boars did not exceed 200 abnormal forms per 1000 spermatozoa. Abnormal forms, ranging from 200 to 500 per 1000, occurred in semen from boars which produced small litters, dead and mummified fetuses, or from boars which failed to settle their sows.

The reliability of estimates of the proportion of morphologically abnormal spermatozoa was determined by Salisbury and Mercier (1945) who concluded that a count of 100 cells in one slide was sufficient basis for estimates. These investigators found that the relationship of most variations in morphology to fertility was not clear. However, Donham *et al.* (1931) and Swanson and Herman (1941) could not correlate the percentage of abnormal spermatozoa with fertility.

McKensie, Miller, and Bauguess (1938) recognized ten different types of abnormality in boar semen. These types were: head-

less, shoe-hooked tails, pyriforms, tail-less, coiled tails, tapering heads, middle piece heads, giant heads, small heads, and undeveloped sperm cells. Coiled tails, followed by middle piece heads which were sometimes enlarged, were by far the most common types of abnormality. Although there were wide variations between different boars, there was a correlation between frequency of ejaculation and the number of abnormal sperm cells per 1000. This was specially true when semen was collected at 12-hour interval.

Lagerlof (1935) as cited by Mckensie, Miller, and Bauguess (1938), said that the number of abnormal spermatozoa should not exceed 200 per 1000 in semen of good breeding bulls. He believed the protoplasmic drop to be an indication of immaturity, and its location on the head, middle piece or tail to be a measure of the degree of immaturity.

Mckensie and Phillips (1934) studied the morphological appearance of ram semen in relation to its fertility and found significant correlation between morphology and fertility.

Moench and Holt (1931) found that fertility was impaired when the number of abnormal sperm heads reached 20 to 23 per cent, and concluded that abnormal sperm heads should not exceed 20 per cent in normal semen. They further believed that sterility usually resulted when the number of abnormal sperm heads exceeded 25 per cent.

Methylene blue reduction test and dead-alive staining.—The rate of color loss of methylene blue when semen is added indicates the hydrogenase activity of the semen. Sorensen (1942), as cited by Emmens and Blackshaw (1956), and Van de Mark and co-workers (1945) found that the rate of methylene blue reduction with semen of the bull was related to spermatozoa motility and density. These workers suggested that this test might be used to measure fertility. Erb *et al.* (1950), on the other hand, found that methylene blue reduction time was more closely related to other semen characteristics than to fertility. Buckner *et al.* (1954) and Bishop and co-workers (1954) confirmed the findings of Erb *et al.*, that significant correlation exists between methylene blue reduction time and other semen characteristics except fertility.

For a serviceable ejaculate, Blom (1950) recommended that the time shown by methylene blue reduction test should not exceed 25 minutes. This greatly exceeded the maximum time of nine minutes allowed by Branton and co-workers (1951).

Shaffer and Almquist (1948) reported that the proportion of living spermatozoa showed a highly significant curvilinear regression with fertility, but the predictive value with relatively good semen was not great. Stone and associates (1950) could not find such correlation and concluded that although there was significant relationship of fertility with the percentage of live or dead spermatozoa, the predictive values were again slight. Wiggins *et al.* (1953), in experiments on rams, found that there was a significant but low correlation of the percentage of live normal spermatozoa with fertility, but that the over-all percentage of live spermatozoa was not related to conception rate.

MATERIALS AND METHODS

Seven Berkshire boars, Nos. 16, 69, 119, 328, 338, 501, and 511, were used in this study. They ranged from three to four years and six months old at the beginning of the experiment. Semen had previously been collected from these boars for about two years.

All boars were given the same care and management and were handled in practically the same manner at collection time. A collection period of ten months was used for boars No. 16, 119, 328, 338, and 501, three and a half months for boar No. 69, and eight months for boar No. 511. All the seven boars were originally intended to be used for a period of one year. However, boar 69 had to be shipped to the U. P. College of Agriculture and used for some other purposes and boar No. 511 was taken to Cebu. From the remaining five the semen collected after the tenth month was found to be devoid of spermatozoa. One of the two probable causes was the outbreak of foot-and-mouth disease in the herd which temporarily stopped the artificial insemination program of the Bureau. Another cause was their frequent use for breeding during the two years preceding this study.

The semen from individual boars was collected by means of artificial vagina and dummy sow. Collections were done around eight o'clock in the morning of the scheduled day. To minimize bacterial contamination, handling and collection were done with care and before collection the boars' sheaths were properly washed and the instruments were sterilized.

The total volume in cubic centimeter per ejaculate was measured, and 10 to 15 cc. of this were placed in clean test tubes. After

initial examinations for motility and concentration of the spermatozoa and for pH value and methylene blue reduction test of the semen at the Bureau of Animal Industry, the test tubes, properly plugged with rubber stoppers, were placed in an improvised kit and shipped by bus to the U.P. College of Agriculture. Four trips starting in Laguna at 6:00 a.m. to Manila, and back again at 10:30 a.m., had to be made weekly for purposes of this study.

Eighty collections were taken from boars Nos. 501, 16, 328, 338, and 119 during a period of ten months. A sample from each ejaculate was subjected from 14 to 15 observations for color, volume, density, motility, methylene blue reduction test, dead-alive staining test, pH, and abnormalities, giving a total of 5600 to 6000 observations. Twenty-eight collections and 392 to 420 observations were made for boar No. 69 during a period of three and a half months, and 64 collections and 896 to 960 observations were made for boar No. 511 during a period of eight months.

These gave a total of 172 collections and 6888 to 7380 observations made in this study.

Motility.—The motility or movement of the spermatozoa was determined microscopically. As in the examination for morphology, two observations were made: one at the Bureau just after collection and the other at the College of Agriculture approximately five hours later. However, more observations were made to determine the length of time for the spermatozoa to reach zero motility.

The procedure for motility examination consisted in placing on a clean glass slide a drop of warm physiological saline solution (38°C. or 100°F.) to which a drop of semen was added. After agitating the mixture gently, a cover glass was placed on top of the diluted semen and then the mixture was examined under the microscope (high power objective). The edges and the center of the spread were closely observed in order to have a better estimate of the percentage of live, active sperm cells.

The sperm cell motility was scored on a percentage basis. Two to three microscopic fields per semen sample were examined carefully to determine the percentage of motile spermatozoa.

Sperm cell concentration per cu. mm.—The determination of sperm cell density per cu. mm. was made once immediately after collection by using a hemocytometer at the Chemistry Division of the Bureau of Animal Industry.

Briefly, the technique followed in determining sperm cell concentration consisted in drawing semen up to the 0.05 mark, after it had been thoroughly mixed in a test tube, into a standard red cell dilution pipette (Ernst Leitz Weitzlar) to the mark just right below the bulb. A small bubble of air was next drawn into the pipette. The end of the pipette was wiped clean. The pipette was then filled to the 1.01 mark (above bulb) with a diluting fluid consisting of three per cent sodium chloride. The pipette was agitated by bumping it against the heel of the hand for about three minutes to insure complete mixture. After discarding the first four or five drops, a drop was run under a cover glass which had been placed previously on the ruled field of the hemocytometer slide. The spermatozoa were counted under the high power objective.

pH values.—With a Beckman pH meter, the pH values of the semen were determined only once after collection. The pH values were standardized every time semen from individual boars were taken.

Morphological abnormalities.—The following outlines the steps used in determining morphological abnormalities.

A stain consisting of one part carbol fuchsin and one part distilled water was prepared. Two to three drops of the stain were placed on a clean glass slide after which a drop of semen was added. The mixture was spread into a very thin film and then air-dried. The excess stain was rinsed off with distilled water and the slide was again air-dried and then examined under the microscope (high power objective). In examining for sperm abnormalities, microscopic fields were taken at random and a hundred or more spermatozoa were counted and classified under different types of abnormalities such as headless, tail-less, coiled tail, shoe-hooked tail, pyriform, and protoplasmic droplets. The percentage of abnormal spermatozoa was obtained by dividing the number of abnormal cells by the total number counted and then multiplying the results by 100.

Methylene blue reduction test.—In performing the methylene blue reduction test, a solution of methylene blue was first prepared by dissolving 50 mg. of methylene blue in 100 cc. of M/15 citrate buffer. The solution was kept in a colored bottle and stored properly when not in use.

Two-tenths cubic centimeter of fresh semen was diluted with 0.8 cc. of egg-yolk-citrate solution (50 cc. of egg yolk and 50 cc. of

sodium citrate solution) in a vial. The mixture was thoroughly agitated by inverting the container three to four times. One-tenth cubic centimeter of methylene blue solution was added and the mixture was again agitated gently. The vial was then plugged and placed in a hot water bath at 110°F. until the color of the solution faded. The methylene blue reduction test is based on the fact that the blue color disappears faster with semen of good quality than with that of poor quality. The methylene blue reduction test was made only once after each collection.

Dead-alive staining test.—To determine the dead and the live spermatozoa at the time of examination, a dead-alive staining test was conducted. The test is based on the fact that live sperm cells do not absorb the dye but remain white. Dead cells, on the other hand, turn purple. In conducting the test enough stain to last the duration of the study was first prepared as follows:

Stain A—25 cc water-soluble eosin in 100 cc of pH 7.3 phosphate buffer (80.4 cc M/8 Na_2PO_4 plus 19.6 cc M/8 KH_2PO_4)

Stain B—Fast Green, F. C. F., 2.0 grams; Eosin B, 0.8 grams; M/8 Phosphate buffer, 100 cc.

One part of stain A was mixed with one part of stain B and the mixture was heated and filtered.

By means of a stirring glass rod, one drop of the mixed stain was placed on a clean glass slide. With the aid of another stirring glass rod, a drop of semen was mixed with the stain. A second glass slide was placed over the smear and the excess stain was removed by wiping the edges of the slides with a piece of tissue paper. The slides were then drawn apart and dried rapidly by placing them on a hot plate (150-200°F.). The ratio of dead to live spermatozoa expressed in percentage was determined by counting 100 or more cells per sample with the aid of a microscope (high power objective).

RESULTS AND DISCUSSIONS

Color of Semen.—The color of semen varied from grayish to milky white. The former predominated in semen collected at one-day interval; the latter in collections at four-day interval. The color depended on the density of spermatozoa: the whiter the color, the greater the sprem cell concentration. This was in accord with the findings of McKensie *et al.* (1938), who found a greater concentration of spermatozoa when semen collections were made at intervals

of 48 hours or longer. The sperm cell concentrations were correspondingly smaller in collections made at an interval of one day or less.

Volume of semen.—The volume of boar semen per ejaculate is much greater than that of other farm animals. The volume varies in different boars and in the same boars on different days. However, almost all workers agree that the average volume per ejaculate is 200 cc. It is interesting to note here that, as reported by Vera Cruz (1957), the volume of boar semen per ejaculate is only half as much when collected by electrical stimulation as when collected by means of an artificial vagina.

The average volume of semen collected at one-day interval was 234.21 cc., with a range of 170.50 to 261.70 cc. The average for the four-day interval was 273.56 cc., the range being 253.00 to 288.20 cc. (table 1). The range for the two-day interval was 170.50 to 288.50 cc. Boar No. 16 consistently gave the highest volume of semen both at one-day and at four-day interval. The average found in this study was higher than the average of 200 cc. reported by various investigators.

TABLE 1.—*Percentage of the gelatinous substance and the liquid portion of semen collected at one- and four-day intervals*

BOAR NO.	ONE-DAY INTERVAL			FOUR-DAY INTERVAL		
	Total volume cc.	Liquid per cent	Gel per cent	Total volume cc.	Liquid per cent	Gel per cent
16	261.70	64.50	35.50	288.20	64.50	35.50
328	245.90	67.78	32.22	287.60	64.42	25.58
511	250.00	65.60	34.40	279.00	65.04	34.96
119	235.20	63.50	36.50	264.50	63.90	34.10
328	170.50	64.50	35.40	251.70	62.50	37.50
69	221.00	66.69	33.31	253.00	67.40	32.60
501	255.20	65.50	34.50	280.90	64.40	35.60
Average	234.21	64.44	34.56	273.56	63.45	36.55

Boar semen consists of a liquid part in addition to lumps of gelatin-like materials resembling tapioca platelets. According to McKensie *et al.* (1938), the liquid part may comprise 60 to 75 per cent of fresh semen. When permitted to cool 24 hours, the gel-like substance may account for as much as 50 to 75 per cent of the weight of the semen. Perry (1952) said that this waxy material acts as a

vaginal seal although, according to Johari (1956) as cited by Vera-Cruz (1957), it may have other functions.

The liquid portion of the semen collected at one-day interval averaged 65.44 per cent, with a range of 63.50 to 67.78 per cent; and that for the four-day interval averaged 63.45 per cent, with a range of 62.50 to 67.40 per cent. The range for the two-day interval was from 62.50 to 67.78 per cent.

The gel-like substance averaged 74.56 per cent in collections at one-day interval, and 35.55 per cent in those at four-day interval. The range for the two-day interval was from 32.22 to 37.50 per cent. The averages found in this study fall within the average range of 30 to 40 per cent reported by McKensie *et al* (1938).

The gel-like substance was opaque and showed, upon microscopic examination, many dead sperms apparently trapped after ejaculation.

Semen motility.—The motility of the spermatozoa was scored according to the method suggested by Herman and Madden (1943) and recommended for local use by Trimberger.[3]

The degree of motility was determined just after the semen was collected, and the observation continued as long as the sperm cells remained motile. The average percentage of initial motility for all the boars was 79.18 per cent, with a range of 76.44 to 81.18 per cent, when semen was collected at one-day interval; and 78 to 99 per cent, with a range of 76.00 to 80.91 per cent, when semen was collected at four-day interval. The initial motility examination was performed at about 8:24 a.m. under an atmospheric temperature of 83.61°F. for both the one-day and four-day intervals. From the results obtained, the length of interval between collections appeared to have had no effect on initial motility (table 2).

A second examination for motility was done 4 hours and 59 minutes on the average, after the initial examination (table 2). Because of the effect of shipment on the semen, the motility showed a marked decrease to 28.31 per cent in semen collected at one-day interval and 28.71 per cent in four-day interval. Subsequent examinations were made until motility was zero. The average duration of motility was found to be 9 hours and 37 minutes for all the boars

[3] Dr. George W. Trimberger was one of the visiting professors from Cornell University who worked for some time on artificial insemination at the College of Agriculture, University of the Philippines.

when collection was made at one-day interval, and 9 hours and 40 minutes at four-day interval (table 3).

TABLE 2.—*Average time of examination and motility of semen collected at one- and four-day intervals*

BOAR NO.	TIME OF INITIAL EXAMINATION (A.M.)		PER CENT INITIAL MOTILITY		ATMOSPHERIC TEMPERATURE (°F.)	TIME OF OBSERVATION (P.M.)		PER CENT MOTILITY	
	1-Day	4-Day	1-Day	4-Day		1-Day	4-Day	1-Day	4-Day
501	8:27	8:20	80.28	80.91	81.65	1:20	1:26	36.25	34.19
69	8:31	8:29	76.44	76.00	85.06	1:27	1:18	22.79	34.70
338	8:15	8:19	76.34	79.42	84.31	1:15	1:19	27.54	29.11
119	8:19	8:33	81.18	80.00	83.89	1:35	1:31	25.03	26.37
511	8:18	8:21	77.65	77.61	83.50	1:22	1:16	29.63	31.01
16	8:25	8:20	79.13	79.40	83.63	1:17	1:27	31.40	30.77
328	8:34	8:23	80.23	79.60	23.21	1:25	1:21	25.51	24.82
Average	8:24	8:24	79.18	78.99	83.61	1:23	1:23	28.31	28.71

Average time interval between examinations: 1-day, 4 hrs, and 59 minutes; 4-day, 4 hrs. and 59 minutes.

TABLE 3.—*Average time interval from initial to zero per cent motility of semen collected at one- and four-day intervals*

BOAR NO.	TIME OF COLLECTION (A.M.)		TIME OF ZERO MOTILITY (P.M.)		TIME INTERVAL FROM INITIAL TO ZERO MOTILITY (Hours & Minutes)	
	1-Day	4-Day	1-Day	4-Day	1-Day	4-Day
501	8:27	8:20	6:31	6:10	10 hrs., 4 min.	9 hrs., 50 min.
69	8:31	8:29	5:42	5:50	9 hrs., 11 min.	9 hrs., 21 min.
338	8:15	8:19	6:10	6:17	9 hrs., 55 min.	9 hrs., 58 min.
119	8:19	8:33	5:15	5:17	9 hrs., 56 min.	8 hrs., 44 min.
511	8:18	8:21	5:44	5:48	9 hrs., 26 min.	9 hrs., 27 min.
16	8:25	8:20	5:57	5:49	9 hrs., 32 min.	9 hrs., 29 min.
328	8:34	8:23	5:21	5:15	9 hrs., 13 min.	8 hrs., 52 min.
Average	8:24	8:24	5:45	5:46	9 hrs., 37 min.	9 hrs., 40 min.

Concentration of spermatozoa.—The initial concentration of spermatozoa of semen collected at one-day interval showed a range of 185,000 to 213,300 per cu. mm., or an average of 193,429 per cu. mm. (table 4). The sperm cell count for semen collected at four-day interval was higher with a range of 208,300 to 236,600 per cu. mm., the average being 219,871 per cu. mm. The range for the two-day interval was from 185,000 to 236,600 per cu. mm. However, the difference of concentration of spermatozoa between the one-day and

four-day intervals of collection was found to be insignificant for all the boars.

TABLE 4.—*Average initial concentration, pH, per cent alive and methylene blue reduction time (MBRT) of semen collected at one- and four-day intervals*

BOAR NO.	CONCENTRATION NUMBER PER CU.MM.		pH		PER CENT ALIVE		MBRT Minutes & Seconds	
	1-Day	4-Day	1-Day	4-Day	1-Day	4-Day	1-Day	4-Day
501	213,300	236,600	7.31	7.31	68.07	68.25	5:56	7:33
69	197,800	220,000	7.38	7.36	65.37	68.15	6:39	6:15
339	188,000	208,300	7.41	7.42	66.04	67.55	6:25	7:10
119	209,700	228,900	7.61	7.62	69.70	67.14	5:52	6:15
511	193,200	210,500	7.50	7.44	64.74	65.50	6:16	6:10
328	202,000	225,400	7.38	7.42	67.37	70.05	5:49	6:14
16	185,000	209,400	7.32	7.33	61.40	68.12	5:42	6:04
Total	1,309,000	1,539,100						
Average	198,429	219,871	7.42	7.41	66.10	67.82	6:06	6:32

pH of semen.—Changes in the pH values of semen may be used to indicate, roughly, the metabolic activity of the spermatozoa. The pH of the semen from all boars showed alkalinity regardless of the difference in length of interval between collections. A pH range of 7.31 to 7.62 for semen samples collected at four-day interval and 7.31 to 7.61 for those collected at one-day interval was obtained. An average pH of 7.42 was obtained for semen collected at one-day interval and 7.41 at four-day interval.

Bratton *et al.* (1954) and Lambert and McKensie (1940) as cited by Kumaran (1951), reported that the pH value of boar semen ranged from 6.8 to 7.2. The values found in this study were higher than those reported by these investigators.

Morphology of the spermatozoa.—Six common types of abnormalities were recognized among the spermatozoa, namely: headless, tail-less, coiled tail, pyriform, shoe-hooked, and protoplasmic droplets. Some minor abnormalities were also observed such as two-headed, giant head, and two-tailed spermatozoa. However, the latter three abnormalities were seldom seen during the morphological observations. The semen collected at one-day interval gave an average of 88.03 per cent initial normal morphology for all the boars (table 5). After the lapse of an average of 5 hours and 18 minutes from the initial examination, including the time spent in shipping the semen

TABLE 5.—*Percentage of sperm cell abnormalities in semen collected at one-day examined initially at the Bureau of Animal Industry and after shipment to the College of Agriculture*

BOAR NO.	TIME INTERVAL	MORPHOLOGY (Percentage)													
		Normal		Headless		Tailless		Coiled Tail		Pyriform		Shoe-Hooked		Protoplasmic droplets	
		BAI	COL	BAI	COL	BAI	COL	BAI	COL	BAI	COL	BAI	COL	BAI	COL
501	5 hrs., 20 min.	88.98	84.43	.58	1.43	1.65	2.56	4.16	.53	.78	.88	.99	.74	.68	.68
69	5 hrs., 15 min.	80.66	76.16	2.92	2.92	3.74	3.19	4.85	2.64	3.57	2.01	2.12	2.62	2.60	2.60
338	5 hrs., 25 min.	89.88	84.30	.88	1.75	1.49	2.64	4.33	7.04	.87	1.19	1.43	1.18	1.32	1.32
119	5 hrs., 10 min.	89.72	84.57	1.47	2.18	1.59	2.99	4.30	6.29	.74	1.21	.92	1.44	1.04	1.04
511	5 hrs., 17 min.	88.28	83.90	1.19	1.86	1.34	2.28	4.20	6.40	1.23	1.87	1.22	1.34	1.60	1.60
328	5 hrs., 22 min.	89.61	84.60	0.73	1.72	1.14	2.02	4.56	6.83	0.64	0.98	1.15	1.47	1.12	1.12
16	5 hrs., 18 min.	89.10	85.16	0.55	1.52	1.41	2.29	4.22	6.48	0.81	0.10	1.13	1.36	0.83	0.90
Total	616 hrs., 23 min.	593.40	593.40	8.32	14.20	11.81	19.63	32.51	46.88	7.46	10.70	8.37	10.04	8.21	9.26
Ave.	5 hrs., 18 min.	88.03	84.77	1.19	2.03	1.69	2.82	4.64	6.70	1.07	1.53	1.20	1.43	1.17	1.32

Legend: BAI—Bureau of Animal Industry
COL—College of Agriculture

from Manila to Laguna, the normal morphology rating decreased to an average of 84.77 per cent for all the boars.. This was to be expected for the jarring of the semen during shipment and the effect of changes in air temperature have been cited as detrimental to the spermatozoa (Swanson and Herman, 1941). Although there were distinct increases in abnormalities after shipment, it was found after a T-test (Comparison Test) that the increase in number of the shoe-hooked and protoplasmic droplets over those found during the initial examinations was insignificant On the other hand, there was a significant increase in the number of headless, tail-less, coiled tail, and pyriform types of sperm cell abnormalities. The results would indicate that the effect of shipment did not influence the number of shoe-hooked and protoplasmic droplets.

The semen collected at one-day and four-day intervals showed an average of 89.03 per cent initial normal spermatozoa. The average initial normal sperms for the one-day and four-day intervals were 88.03 and 89.03 per cent, respectively. The difference in the number of abnormal spermatozoa between the one-day and the four-day collection intervals was significant. The only significant deviation in the pyriform type abnormality was observed in boar No. 501.

Methylene blue reduction test.—Semen containing a high concentration of active spermatozoa respires more actively and uses oxygen at a more rapid rate than poor-quality semen. One consequence of respiration is the production of reduced or reducing intermediates which react with the methylene blue (chloride) to form leucomethylene blue or colorless methylene blue. The relative length of time required for the blue color to disappear was presumed to indicate the concentration of active spermatozoa in the semen.

The methylene blue reduction time was recorded in minutes and seconds. At one-day interval, boar No. 16 gave the fastest reduction time—an average of 5 minutes and 42 seconds as compared with 6 minutes and 39 seconds for boar No. 69 (table 4). At four-day interval, the fastest reduction time was 6 minutes and 4 seconds, also recorded by boar No. 16 with a sperm cell concentration of 209,400 per cu. mm., compared with 7 minutes and 33 seconds registered by boar No. 501, with a sperm cell concentration of 236,600 per cu. mm. The same results were obtained in the over-all average of the reduction time at both one-day and four-day intervals. As shown in table 4, an average reduction time of 6 minutes and 6 seconds was required for semen collected at the one-day interval with a lower

sperm cell concentration, and 6 minutes and 32 seconds for that collected at the four-day interval with a higher cell concentration.

These results do not seem to bear out the statement that methylene blue reduction occurs at a faster rate with semen of high quality than with one of poor quality. However, according to Herman and Madden (1943), although the reduction time depends largely on the concentration and activity of spermatozoa, it is also influenced to some degree by other factors like bacterial contamination, light, the presence of enzymes and other factors. The difference in results as observed in this study might have been due to the latter factors.

Correlation of initial motility with methylene blue reduction test.—The correlation between initial motility and the methylene blue reduction time was determined separately for the one-day and four-day intervals of semen collection. Regardless of the interval between collections, there was a significant correlation between the initial motility and the methylene blue reduction time for all boars except boar No. 69. No satisfactory explanation for this deviation can be offered except that the data obtained from this animal were incomplete, for the boar was used for only three and a half months of study.

Dead-alive staining.—According to Perry (1952) dead-alive staining test gives a more accurate evaluation of semen fertility. The process, however, requires careful laboratory work.

The percentage of dead-alive spermatozoa was determined for both one-day and four-day intervals by using the eosin-fast green stain combination. At one-day interval, boar No. 119 showed the highest percentage of live spermatozoa with 69.70 per cent; boar No. 16 gave the lowest with 61.40 per cent. At four-day interval, boar No. 511 gave the lowest with 65.50 per cent and boar No. 501, the highest with 68.25 per cent (table 4). The range for the two-day interval was from 61.40 to 70.05 per cent. An average of 66.10 and 67.82 per cent of live spermatozoa was found for the one-day and four-day interval semen collection, respectively.

Correlation of atmospheric temperature with volume, initial motility, concentration, and dead-alive percentage.—Because of the time element involved in the shipment of semen from Manila to Laguna, it was thought best to correlate only the effects of atmospheric temperature on semen quality during collection time.

The atmospheric temperature at the time of collection was taken from the Weather Bureau in Manila. The average atmospheric temperatures during the 10-month period of study for individual boars at the time of collection are shown in table 2.

It was found that for all the seven boars, there were no significant correlations at the time of collection between temperature and volume, temperature and concentration, temperature and live spermatozoa, and temperature and dead spermatozoa. However, a significant correlation was found between atmospheric temperature at the time of collection and initial motility. Similar results were found by Swanson and Herman (1941) in their studies on bull semen.

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NOTE: EFFECT OF GIBBERELLIC ACID ON THE FIBER OF KENAF

(*Hibiscus cannabinus* L.)

Gibberellic acid, the growth regulator which was isolated from the rice disease fungus,, *Gibberella fujikuri* (Saw) Wr., induces the rapid elongation of plants in general. This property may be anticipated to be of some practical value in increasing the yield of fiber from kenaf. To explore the prospect, sixteen potted kenaf seedlings, about two weeks of age, were divided into four lots and given the following treatments: Lot I, no treatment; lot II, 10 ppm gibberellic acid; lot III, 50 ppm; and lot IV, 100 ppm. One drop of the solution was applied to the apex of the plant. A wad of cotton was placed at the apex to prevent excess solution from dripping down the stem. Treatments were repeated every week until the plants flowered.

Even as early as one week after the first application, the treated plants were already taller than the untreated plants (fig. 1). The

Fig. 1. Effect of various concentrations on stem elongation after the second treatment. From the left: control, 10 ppm, 50 ppm, and 100 ppm.

more concentrated the growth regulator, the higher was the weekly increment in stem length (table 1). At the final observation, however, there was little difference in height between the 50 ppm and the 100 ppm treatments—the two highest (fig. 2).

Fig. 2. Effect of various concentrations of gibberellic acid on stem elongation after the fifth and last treatment.

On the dry weight basis, the percentage of fiber extraction were 3.49, 3.71, 4.19, and 4.13 for 0, 10, 50 and 100 ppm treatments, respectively. This increased percentage of fiber extraction was reflected in the amount of fiber obtained from each shoot, which were 1.53, 1.80, 2.61 and 2.55 grams, in the order of increasing concentration

TABLE 1.—*Average weekly stem increments after treatments with gibberellic acid (cm.)*

TREATMENT	AGE IN WEEKS				
	3	4	5	6	7
0	8.25	12.75	13.75	13.25	10.5
10 ppm	10.75	13.5	14.5	13.75	18.5
50 ppm	14.75	16.75	16.5	14.0	23.0
100 ppm	13.75	19.5	19.75	16.75	23.0
SMD (T)	5% = 2.8122				
	1% = 3.9474				

TABLE 2.—*The effect of gibberellic acid on kenaf fiber*

TREATMENT	REPLICATION	% FIBER EXTRACTION	TENSILE STRENGTH (KM)	AMOUNT OF DRY FIBER/SHOOT (GM)
0	1	3.14	20.36	1.6
	2	2.85	27.77	1.1
	3	3.91	28.23	1.6
	4	4.05	28.12	1.8
Total		13.95	104.48	6.1
Mean		3.49	26.12	1.53
10 ppm	1	4.00	23.31	2.1
	2	3.54	22.85	1.9
	3	3.66	28.3	1.4
	4	3.65	23.8	1.8
Total		14.85	98.26	7.2
Mean		3.71	24.57	1.8
50 ppm	1	3.39	26.8	2.4
	2	4.2	26.5	2.95
	3	4.53	22.85	2.8
	4	4.64	24.28	2.3
Total		16.76	100.43	10.45
Mean		4.19	25.11	2.61
100 ppm	1	3.94	25.56	2.1
	2	3.8	22.27	2.8
	3	3.87	26.4	2.2
	4	4.91	28.44	3.1
Total		16.52	102.67	10.2
Mean		4.13	25.67	2.55
SMD (T)	5%	a	a	0.2389
	1%	a	a	0.3435

[a] Insignificant.

of the growth regulator. There was no apparent effect of treatment on the strength of the fiber as tested in the tensilograph machine. Average measurements of representative phloem fibers were: control, 2.92 mm. long, 0.021 mm. wide and 0.0062 mm. thickness of wall; 10 ppm gibberellic acid, 3.05 mm. by 0.025 mm. by 0.0076 mm.; 50 ppm, 2.71 mm. by 0.024 mm. by 0.0073 mm.; and 100 ppm, 3.57 mm. by 0.024 mm. by 0.0068 mm. Differences among treatments were not significant.

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Maria F. Caluya and Jaman S. Imlan

NOTE: CYTOLOGY OF PHILIPPINE PLANTS II. *SOLANUM GRANDIFLORUM* RUIZ AND PAV.

One plant that may be of great importance in the improvement of eggplant is its relative, *Solanum grandiflorum* Ruiz and Pav. Crosses between this species and the eggplant could make possible the incorporation of the perennial habit and resistance to the more common eggplant diseases and pests to the latter.

A botanical description of *Solanum grandiflorum* Ruiz and Pav. is as follows:

> It is a rather coarse shrub or small tree. Branches yellowish-gray felty, sparsely beset with minute prickles. Leaves large, 2 dm. long, 12 cm. wide, thickly coriaceous, felty tomentose beneath, stellately-pubescent on the upper, the base unequal, truncately rounded, subelliptic, dentately lobed or coarsely toothed. Flowers on stout peduncle, axillary, lilac or pale blue, corolla lobes silky tomentose on the outside, rotately spreading, gradually pointed; anthers elongated, sparsely ciliate along the connective; style curved, somewhat hairy. Fruit a berry, 3 to 5 cm. across, globose, apparently yellowish when mature, densely tomentose, subtended by a thickened calyx rim.

Young flower buds were collected and fixed, using Farmers' fluid. Microsporocytes were studied by the standard acetocarmine smear technique.

OBSERVATIONS

Meiosis in *Solanum grandiflorum* is normal although pachytene analysis was hardly possible on account of the clumping of the chromosome threads. The thickened chromosomes at diakinesis (Fig. 1) and Metaphase II (Fig. 2) spread quite well making the chromosome count much easier. Twelve pairs of chromosomes were observed indicating that *S. grandiflorum* is a diploid, the basic number of Solanum being 12. With this information, the crossability of this species and eggplant could be promising since both have the same chromosome number.

—Dolores A. Ramirez

Fig. 1. *S. grandiflorum* sporocyte at diakinesis stage.

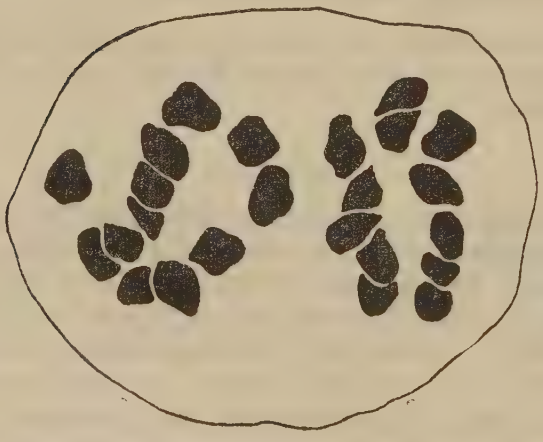

Fig. 2. Metaphase II of *S. grandiflorum* sporocyte.

NOTE: CYTOLOGY OF PHILIPPINE PLANTS III. *LANSIUM DOMESTICUM* CORR.

Lanzones (*Lansium domesticum* Corr.) is one of the most popular fruits in the Philippines. The studies so far conducted are limited to the agronomic characters and chemical properties of its fruits. Neither the cytology of this fruit tree nor that of any other species belonging to the genus *Lansium* has been reported.

Three varieties of lanzones are grown in the College orchard, namely, Laguna (College selection), Mindanao, and Duku. The last is a variety from Java while the other two are both named after the places where they are collected. The Mindanao variety is characterized by its widespreading branches, broad leaves, and big sour fruits. It grows wild in the southern parts of the Philippines. On the other hand, the Laguna variety has generally slender upright branches, narrow leaves, and medium-sized sweet fruits. This cultivated variety is extensively grown in Laguna and Quezon. The Duku variety has a habit of growth intermediate between the two, but the fruits are about as big as the Mindanao variety and much sweeter than the College selection.

Flower buds were collected from the Mindanao and Laguna varieties and the sporocytes were studied as soon as possible following fixation with the Farmers' fluid. Cytological examinations of the microsporocytes were made employing the standard acetocarmine smear technique.

OBSERVATIONS

The Mindanao and Laguna varieties of lanzones did not differ in the cytological features studied. Both have the same meiotic behavior and were found to have 72 pairs of chromosomes (Fig. 1b). A fairly good spread of the chromosomes at the diakinesis stage made possible the accurate chromosome count (Fig. 1b). The chromosomes were observed to have a fairly wide range of sizes. The genera Melia and Flinderia which, together with Lansium, belongs to the family Meliaceae have a basic chromosome number of 14 and 18, respectively (Darlington, 1956). Based on these, it is logical to assume that lanzones is an octoploid with a basic chromosome number of 18.

The chromosal threads at pachynema were so closely clumped that the analysis of individual chromosomes was hardly possible. Knobs were observed but their locations could not be ascertained.

At metaphase I, precocious disjunction of several chromosomes was observed (Fig. 1c). Aside from disjoining much earlier as compared with the rest of the chromosomes in the complement, stickiness was also observed among them. Another phenomenon observed at metaphase I was the irregular orientation of the bivalents at the equatorial plate: some had the centromeres lying vertically; others, horizontally. The precocious disjunction and irregular orientation of the chromosomes were also observed at metaphase II (Fig. 1e).

Cystokinesis begins soon after the second division and was observed to be both irregular and elaborate, resulting to polyspory and cytoplasmic break down of some daughter cells (Fig. 1f). Some spores received chromosomes while others were just filled with cytoplasm. Empty and partially filled pollen grains both of various sizes were observed. These might be those spores that did not get chromosomes during cytokinesis.

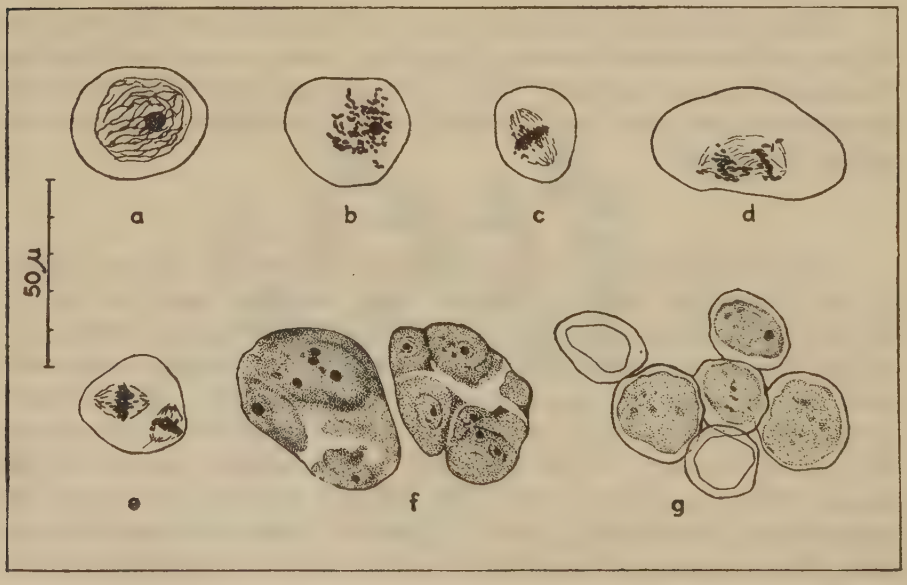

Fig. 1. Camera lucida drawings of the meiotic stages of lanzones sporocytes. a—pachynema; b—diakinesis; c—metaphase I; d—anaphase I; e—metaphase II; f—cytokinesis; g—pollen grains.

Acetocarmine smears of mature anthers revealed only several plump, well-staining and apparently normal pollen grains. This very high sterility is most probably due to the irregular cystokinesis, and the nuclear- and cytoplasm-deficient spores that naturally results from the formation of polyspores.

—*F. A. Bernardo and D. A. Ramirez*

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